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Research on Analysis Techniques for OFDM

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ABSTRACT: FDMA, TDMA and CDMA are the well known multiplexing techniques used in wireless communication systems. While working with the wireless systems using these techniques various problems encountered are (1) multi-path fading (2) time dispersion which lead to symbol interference (ISI) (3) lower bit rate capacity (4) requirement of larger transmit power for high bit rate and (5) less spectral efficiency. In a typical terrestrial broadcasting, the transmitted signal arrives at the receiver using various paths of different lengths. Since multiple versions of the signal interfere with each other, it becomes difficult to extract the original information. The use of orthogonal frequency division multiplexing (OFDM) technique provides better solution for the above mentioned problems. OFDM technique distributes the data over a large number of carriers that are spaced apart at precise frequencies. This spacing provides the "orthogonality", which prevents the demodulator from seeing frequencies other than theirown. The benefits of OFDM are high spectral efficiency, resiliency of RF interference, and lower multi-path distortion. OFDM is a powerful modulation technique that is capable of high data rate and is able to eliminate ISI. The use of FFT technique to implement modulation and demodulation functions makes it computationally more efficient. The OFDM based wireless communication system design includes the design of OFDM transmitter, and OFDM receiver.

Using MATLAB, simulation of OFDM was done with different modulation techniques using different transform techniques. The digital modulation schemes such as BPSK and QPSK were From the simulation results, it is observed that the BPSK allows the BER to be improved in a noisy channel at the cost of maximum data transmission capacity. Use of QPSK allows higher transmission capacity, but at the cost of slight increase in the probability of error. From the results, use of OFDM with QPSK is beneficial for short distance transmission link, whereas for long distance transmission link OFDM with BPSK will be preferable.

Maximum likelihood Estimation method is used for the prediction of timing and frequency offsets introduced by channel.It has been shown that ML estimation method improves the performance of the system very effectively. There are several other techniques also for prediction of timing and frequency offsets of an OFDM system., but in this paper ML is main area of consideration

I. INTRODUCTION

In a basic communication system, data is processed into a single network company frequency. The available bandwidth is then fully utilized for each character. This type of system can lead to inter-symbol (ISI) disruption in the selection process. OFDM's basic idea is to divide the available spectrum into a few orthogonal channels so that each sub-channel of each sub-band is almost blurred. Orthogonal frequency division multiplexing (OFDM) becomes the preferred method for switching to wireless communication. OFDM can provide large amounts of data with sufficient power to damage a radio station. Many research institutes around the world have specialized teams working to develop OFDM programs. In the OFDM system, a large number of orthogonal, scattered, small belts carrying sub-carriers are transmitted equally. These network companies divide the available bandwidth. The classification of sub- carriers is that there is a combined spectral use. With OFDM, it is possible to have smaller channels scattered throughout the frequency range, thus increasing the transmission rate.

OFDM complaint is mainly due to the multidisciplinary approach to the recipient. The multipath phenomenon creates two effects (a) Frequency selection frequency and (b) Intersymbol (ISI) disorders.

The "flatness" seen by the narrowband channel overcomes the selected blur. On the other hand, low- cost modeling

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signals make the signals much

than the channel response and thus reduce ISI. The use of corrective error codes provides great strength against the blurring of choice of frequencies. The inclusion of additional security measures within the successive OFDM signals may further reduce ISI effects. The use of FFT methods for flexible use and retrieval functions enables it to use the computer more efficiently. OFDM programs have received a lot of interest over the years. It is used in the European digital broadcasting system, as well as in wireless subscription lines such as digital asymmetric subscription lines (ADSL). This process is used in digital registration lines (DSL) to provide maximum bit rate over twisted cables.

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II. LITERATURE REVIEW

The concept of using parallel data transmission by means of frequency division multiplexing (FDM) was published in mid 60's [23, 24]. Some early development with this can be traced back to the 50s. A U.S. patent was filled and issued in January 1970. The idea was to use parallel data streams and FDM with overlapping sub channels to avoid the use of high-speed equalization and to combat impulsive noise, and multipath distortion as well as to fully use the available bandwidth. The initial applications were in the military communications. In the telecommunications field, the terms of discrete multi-tone (DMT), multichannel modulation and multicarrier modulation (MCM) are widely used and sometimes they are interchangeable with OFDM. In OFDM, each carrier is orthogonal to all other carriers. However, this condition is not always maintained in MCM. OFDM is an optimal version of multicarrier transmission schemes. Weinstein and Ebert [25] applied the discrete Fourier transform (DFT) [12] to parallel data transmission system as part of the modulation and demodulation process.

1. Multiple Techniques:

Multiple access techniques are used side by side in cellular systems. The need for multiple access technology stems from the need to share limited radio frequency resources among many users. Use multiple access methods to allow many mobile users to share a limited amount of radio spectrum at the same time. Spectrum sharing is required to achieve high capacity by allocating available bandwidth (or amount of channels) to multiple users at the same time

Duplication

In wireless communication systems, it is often desirable for subscribers to be able to simultaneously send information to a base station and receive information from the base station at the same time. This effect is called a duplexer, and a device called a duplexer is used by each subscriber unit and base station. Duplication can be performed using frequency or time domain techniques. Figure 2.1 shows FDD (Frequency Division Duplex) and TDD (Time Division Duplex). Frequency Division Duplex (FDD) provides each user with two different frequency bands. The forward bandwidth provides base station to mobile traffic, and the reverse bandwidth provides mobile to base station traffic.

Time Division Duplex (TDD) uses time instead of frequency to provide both forward and reverse links. In TDD, multiple users take turns sharing a single radio channel in the time domain. Individual seers can access the channel in the assigned time slot. Each duplex channel has both forward and reverse time slots to facilitate bidirectional communication.

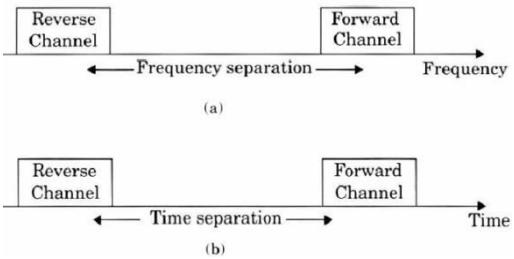

Fig 3.1: (a) FDD provides two simplex channels at the same time;
(b) TDD provides two simplex time slots at the same frequency

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TDMA (Time department more than one get entry to): Time division a couple of get right of entry to (TDMA) improves spectrum ability by means of splitting each frequency into time slots. TDMA lets in each user to get right of entry to the whole radio frequency channel for the fast length of a call. other users percentage this same frequency channel at exceptional time slots. the bottom station always switches from user to user on the channel. TDMA is the dominant era for the second generation mobile cell networks. TDMA machine divide the radio spectrum into time slots, and in every slot simplest one consumer is permitted to transmit and receive. it could be visible from figure 2.3 that each person occupies a cyclically repeating time slot, so a channel can be notion of as a specific time slot that reoccurs every frame, where N time

2.1.1 CDMA (*Code Division Multiple Access*)**:** Code department more than one get entry to is primarily based on "unfold" spectrum era. when you consider that it is suitable for encrypted transmissions, it has lengthy been used for army functions. CDMA will increase spectrum capacity by means of allowing all customers to occupy

III. DIGITAL MODULATION TECHNIQUES

Modulation is the manner of facilitating the switch of statistics over a medium. Sound transmission in air has restrained variety for the amount of electricity your lungs can generate. to increase the range your voice can reach, we want to transmit it through a medium other than air, inclusive of a smartphone line or radio. The procedure of converting records (voice in this situation) in order that it is able to be effectively sent thru a medium (cord or radio waves) is called modulation.

There are three fundamental varieties of virtual modulation techniques. those are

1. Amplitude-Shift Keying (ASK)
2. Frequency-Shift Keying (FSK)
3. segment-Shift Keying (PSK)

All of these strategies range a parameter of a sinusoid to represent the statistics which we want to ship. A standard service wave may be written: $C(t)=A\sin(2\pi feet+\Phi)$

A sinusoid has 3 one of a kind parameter than can be varied. these are its amplitude, phase and frequency. Modulation is a method of mapping such that it takes your voice (as an instance of a signal) converts it into a few element of a sine wave after which transmits the sine wave, leaving the real voice at the back of. The sine wave on the alternative aspect is remapped back to a near reproduction of your sound.

In ASK, the amplitude of the service is modified in reaction to information and all else is stored fixed. In Binary ASK Bit 1 is transmitted by means of a service of one unique amplitude. To transmit zero, we change the amplitude preserving the frequency steady. On-Off Keying (OOK) is a unique form of ASK, wherein one of the amplitudes is zero as shown in fig three.1 and fig 4.1.

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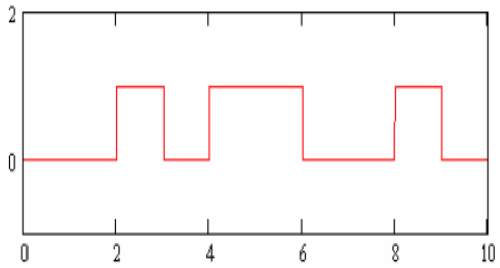

Figure 4.1 - Baseband information sequence – 0010110010

Binary ASK(t)=s(t)sin(2πft)

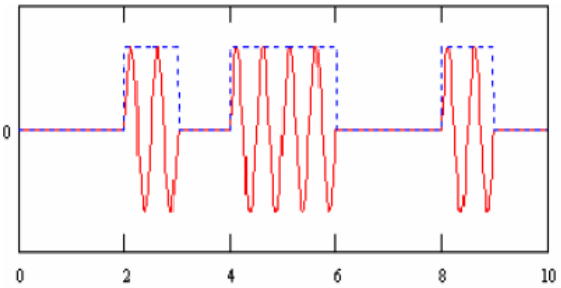

Figure 4.2 - Binary ASK (OOK) signal

In PSK, we change the phase of the sinusoidal carrier to indicate information. Phase in this context is the starting angle at which the sinusoid starts. The transmitted signal is a sinusoid of fixed amplitude. Phase shift keying is a modulation process whereby the input signal, a binary PCM waveform, shifts the output waveform to one of a fixed number of states. The general analytic expression for PSK is

2E

s(t) = ( )1/2cos [m + $(t)]

i T 0 i

For Binary PSK It has one fixed phase usually 0° when the data is 1. To transmit 0, we shift the phase of the sinusoid by 180°. Phase shift represents the change in the state of the information in this case. ASK techniques are most susceptible to the effects of non-linear devices which compress and distort signal amplitude. To avoid such distortion, the system must be operated in the linear range, away from the point of maximum power where most of the non-linear behavior occurs. The use of phase shift keying produces a constant amplitude signal and was chosen for its simplicity and to reduce problems with amplitude fluctuations due to fading.

All of these strategies range a parameter of a sinusoid to represent the statistics which we want to ship. A standard service wave may be written: C(t)=Asin(2πfeet+Φ)

A sinusoid has 3 one of a kind parameter than can be varied. these are its amplitude, phase and frequency. Modulation is a method of mapping such that it takes your voice (as an instance of a signal) converts it into a few element of a sine wave after which transmits the sine wave, leaving the real voice at the back of. The sine wave on the alternative aspect is remapped back to a near reproduction of your sound.

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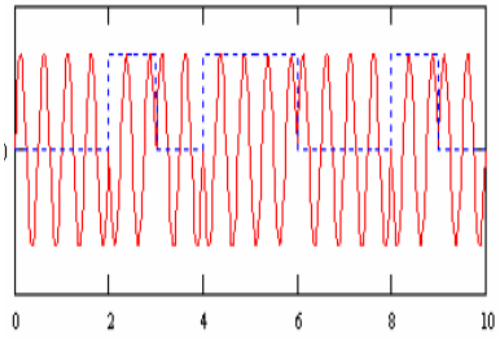

Figure 4.3 - Binary PSK Carrier (Note the 180°phase shifts at bit edges)

BPSK

In binary phase shift keying (BPSK) the transmitted signal is a sinusoid of fixed amplitude. BPSK is the simplest form of PSK. It uses two phases which are separated by 180° and so can also be termed 2-PSK. It has one fixed phase when the data is at one level and when the data is at another level the phase is different by 180°. It does not particularly matter exactly where the constellation points are positioned, and in this figure they are shown on the real axis, at 0° and 180°. This modulation is the most robust of all the PSK's, since it takes serious distortion to make the demodulator reach an incorrect decision. It is, however, only able to modulate at 1 bit/symbol (as seen in the figure 3.4) and so is unsuitable for high data-rate applications when bandwidth is limited.

IMPORTANCE OF ORTHOGONALITY

the principle idea in OFDM is orthogonality of the sub-vendors. The "orthogonal" a part of the OFDM call indicates that there's a precise mathematic al relationship among the frequencies of the providers inside the device. it's far possible to set up the vendors in an OFDM signal so that the sidebands of the man or woman companies overlap and the signals can nevertheless be acquired with out adjacent providers interference. with a purpose to do that the carriers must be mathematically orthogonal. The companies are linearly impartial (i.e. orthogonal) if the provider spacing is a multiple of one/Ts.

wherein, Tsis the symbol length. The orthogonality a few of the carriers can be maintained if the OFDM sign is described by using the use of Fourier transform tactics. The OFDM gadget transmits a big number of narrowband providers, that are carefully spaced. word that on the critical frequency of the every sub channel there may be no crosstalk from other sub channels

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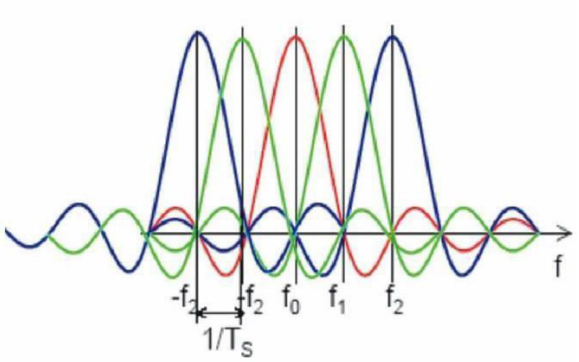

Fig 4.3Example of OFDM spectrum for 5 orthogonal carriers

IV. CONCLUSION

The OFDM makes efficient use of to be had spectrum by permitting overlapping most of the vendors. It basically converts the excessive facts rate flow in to numerous parallel lower data charge streams and thereby removing the frequency selective fading. it's been visible that the OFDM is a effective modulation technique this is able to high statistics charge and is able to do away with ISI. it's far computationally green because of using FFT techniques to put into effect modulation and demodulation functions.
From the simulation consequences, it's far determined that the BPSK lets in the BER to be stepped forward in a noisy channel on the price of most records transmission capacity. Use of QPSK allows higher transmission capability, however at the cost of slight growth inside the opportunity of errors. this is due to the reality that QPSK uses two bits per image. hence QPSK is easily affected by the noise. therefore OFDM with QPSK requires large transmit power. From the outcomes, use of OFDM with QPSK is useful for short distance transmission link, while for lengthy distance transmission link OFDM with BPSK may be ultimate. most chance estimation technique become implemente d for the calculation of timing and frequency offsets .these frequency offsets are discovered to disturb the orthogonality of the OFDM symbols. And it turned into located that the use of this ML estimation technique we will improve the performance of any OFDM system.

There are numerous different techniques also to predict the timing an frequency offsets delivered by the system.9. Lighter vehicles cause less damage to roads, resulting in lower maintenance cost.

The following are the some of the interesting extensions of the present work:

1) An interesting topic for future research is to perform more extensive performance comparisons between FFT based OFDM, DHT based OFDM, and DCT based OFDM systems under additional real-world channel impairments, such as multipath fading, time dispersion whish leads to inter symbol interference(ISI).

2) The main problems with OFDM signal is very sensitive to carrier frequency offset, and its high Peak to Average Power Ratio (PAPR). So, these three transform based OFDM systemscan be tested for theseproblems.

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